NASAfacts

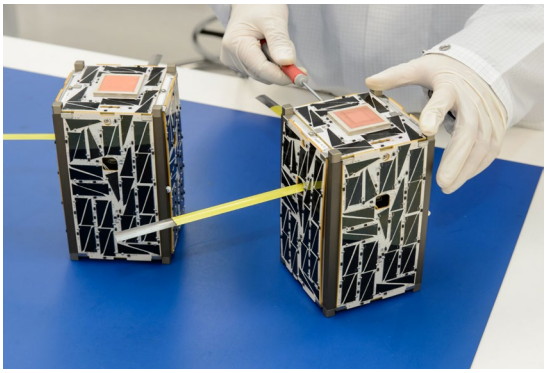
Nodes

Spacecraft Network Operations Demonstration Using Multiple Spacecraft in an Autonomously Configured Space Network Allowing Crosslink Communications and Multipoint Scientific Measurements

Nodes is a technology demonstration mission that was launched to the International Space Station on Dec. 6, 2015. The two Nodes satellites will be deployed from the Station in March 2016 to demonstrate new network capabilities critical to the operation of swarms of spacecraft. They will demonstrate the ability of multi-spacecraft swarms to receive and distribute ground commands, exchange information periodically, and autonomously configure the network by determining which spacecraft should communicate with the ground each day of the mission.

The Nodes mission consists of two 1.5-unit (1.5U) CubeSats, each weighing approximately 4.5 pounds (2 kilograms) and measuring about 4 inches x 4 inches x 6.5 inches (10 centimeters x 10 centimeters x 16 centimeters). The satellite hardware is identical to that developed for the Edison Demonstration of Smallsat Networks (EDSN) mission (a swarm of eight satellites designed to also test satellite swarm capabilities), however the EDSN software capabilities have been enhanced for the Nodes mission. Nodes and EDSN continue the legacy of the Phonesat series that introduced the use of commercial Android smartphone technology to perform many of the spacecraft functions normally accomplished with expensive, customized electronics components.

Each of the Nodes satellites uses the Android operating system with specific software programmed to perform command and data handling tasks that allow the satellites to relay ground commands from one satellite to the other; relay science data on the space radiation environment collected by each satellite to the ground station; and autonomously determine which of the two satellites is best suited to control the space network and relay data to the ground, while also notifying the ground system and second satellite of the results.



Nodes Spacecraft

Each spacecraft has three radios: one S-band radio for ground communication, one ultra high frequency (UHF) radio for crosslink communication, and an additional UHF beacon radio that transmits state-of-health information.

The science instruments, which are identical to those on the EDSN satellites, will collect data on the charged particle environment at an altitude of about 250 miles (400 kilometers) above Earth. As with the EDSN mission, the satellites will form a hub and spoke network to share data and transmit it to the ground, but in this case with only two satellites in the network. The enhanced software capability of Nodes will enable the satellites to automatically select which one of the two is best suited to serve as the ground relay each day, based on exchanging key parameters such as the state of satellite health and the proximity of each satellite to the ground station. Commands will be sent every day from the ground to the selected relay satellite and that satellite will transmit the commands to the other satellite, showing that a network of satellites can be controlled without communicating to each satellite directly.

Each Nodes spacecraft will collect multiple coordinated readings of Earth's charged

particle environment and pass the data to the "Captain" spacecraft for downlink to the ground. The selection of the Captain will be made roughly once per day based on the exchange of key parameters, such as how much science data have been collected and the state of spacecraft health.

The planned mission duration for Nodes is approximately two weeks. The satellites are expected to remain in orbit for up to six months but after two weeks it is expected that the satellites will be more than 60 miles (100 kilometers) apart, making it difficult for them to communicate with their UHF radios.

Networked swarms of small spacecraft will open new horizons in astronomy, Earth observation, and solar physics. Their range of applications includes the formation of synthetic aperture radars for Earth sensing systems, as well as large aperture observatories for next-generation telescopes and the collection measurements distributed over space and of time to study the Earth's magnetosphere, gravity field, and Earth-Sun interactions.

The Nodes project was developed and managed by NASA's Ames Research Center at Moffett Field, California. Santa Clara University provides the mission operations team. Montana State University provided the instruments for measuring the charged particle environment.

The Nodes mission is funded by NASA's Small Spacecraft Technology Program (SSTP), which is chartered to develop and mature technologies to enhance and expand the capabilities of small spacecraft with a particular focus on communications, propulsion, pointing, power, and autonomous operations. SSTP is one of nine programs within NASA's Space Technology Mission Directorate.

For more information about the SSTP, visit:
http://www.nasa.gov/smallsats

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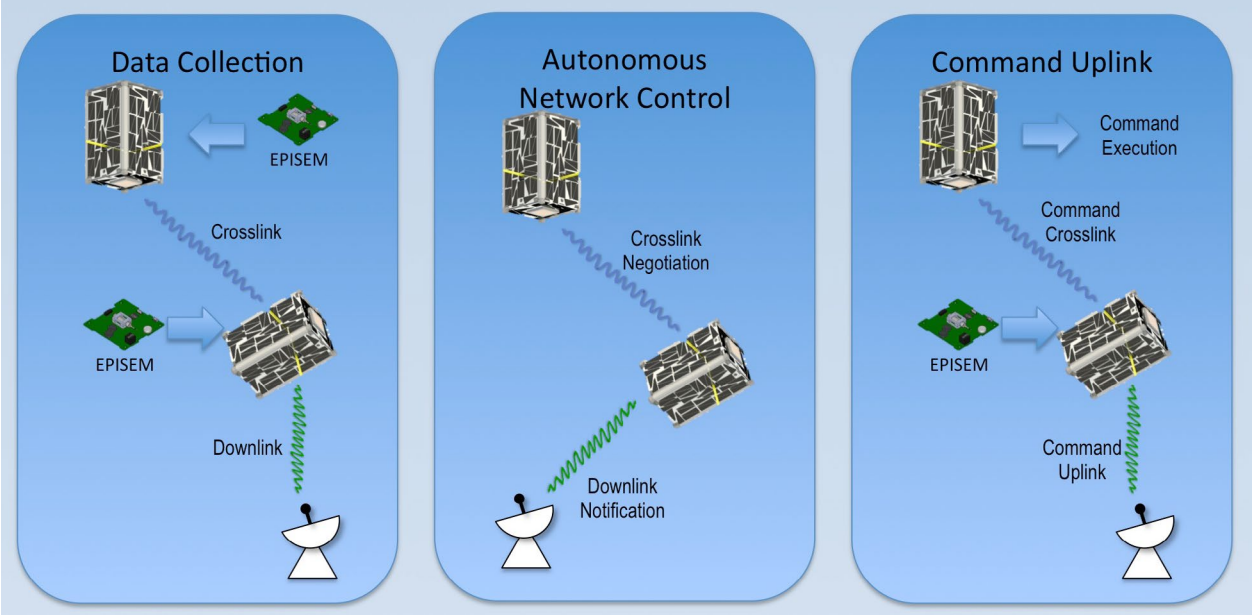

Nodes Inter-Satellite and Space-to-Ground Communications Concept of Operations

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